Capturing photons with the 3D-Flow Architecture

The total energy of the incident photon that was split among several neighboring channels must be reconstructed.

Photon's arrival time, local maxima, centroid, depth-of-interaction (DOI) must be calculated

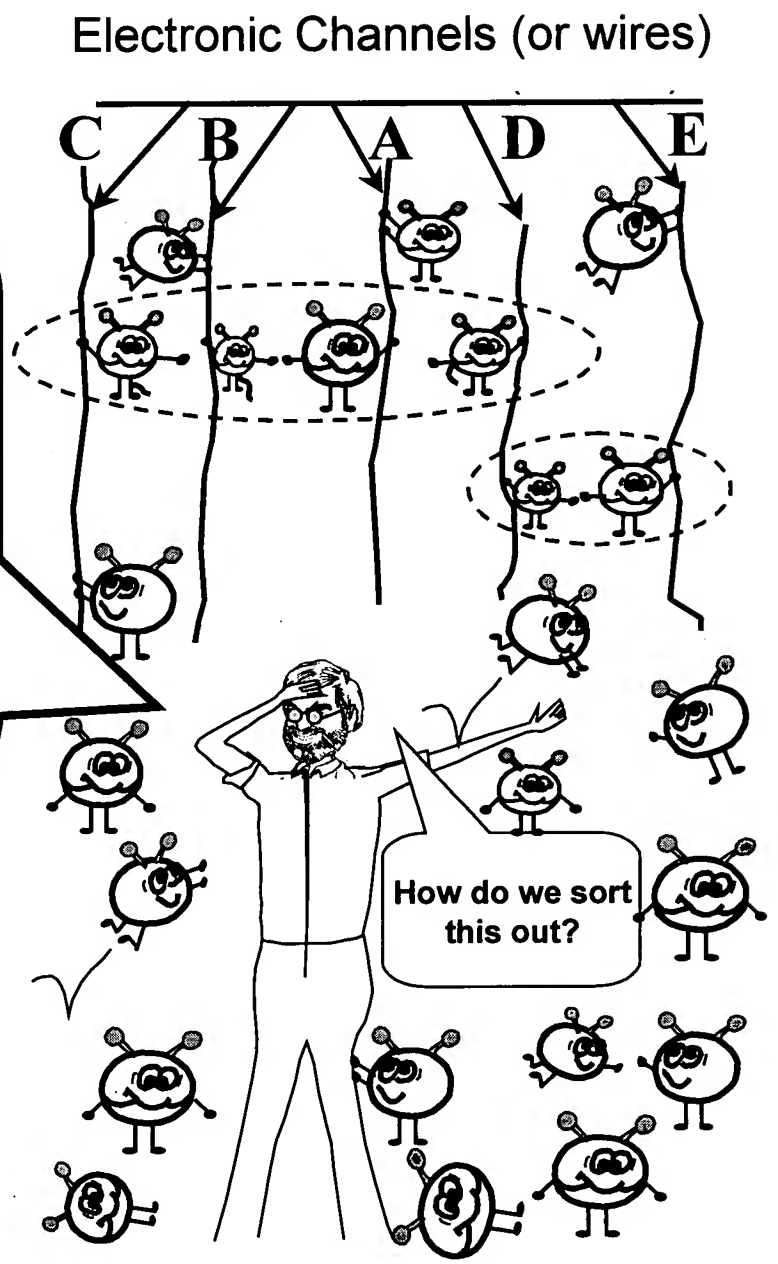


FIG. 1

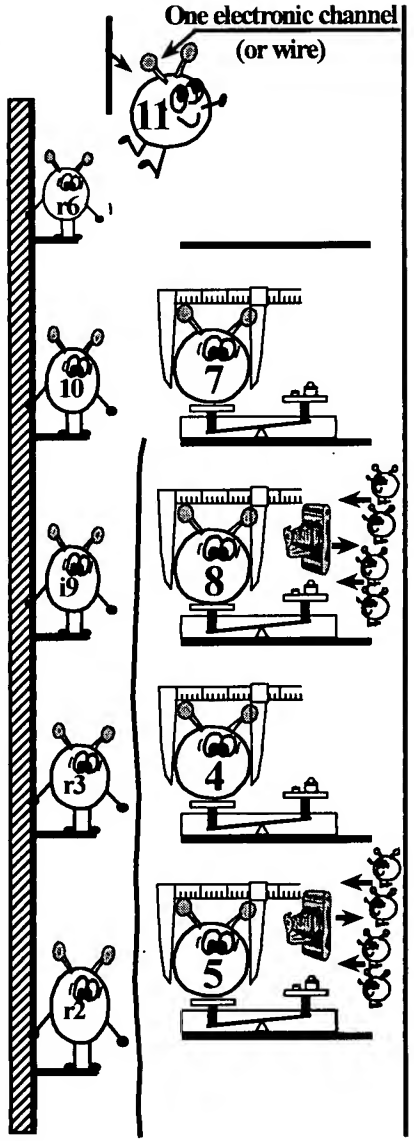

One electronic channel
(or wire)
11
r6
10
7
i9
8
r3
4
r2
5

FIG. 2A

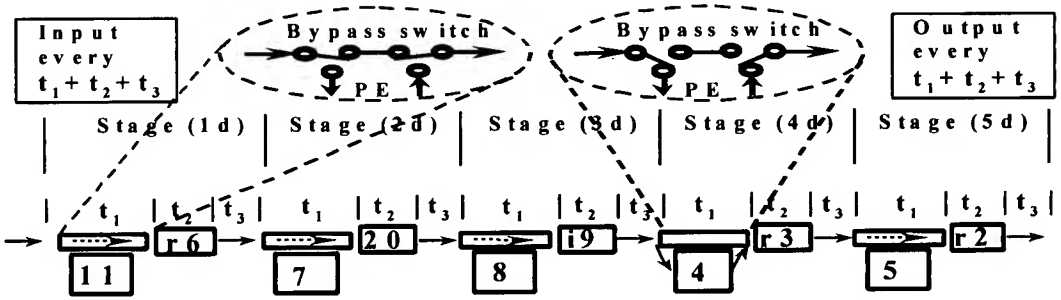

Input every $t_1+t_2+t_3$
Bypass switch
PE
Bypass switch
PE
Output every $t_1+t_2+t_3$
Stage (1d)
Stage (2d)
Stage (3d)
Stage (4d)
Stage (5d)
t_1 t_2 t_3
11
r 6
7
20
8
19
4
r 3
5
r 2

FIG. 2C

Time	Proc (1d)	Reg (1d)	Proc (2d)	Reg (2d)	Proc (3d)	Reg (3d)	Proc (4d)	Reg (4d)	Proc (5d)	Reg (5d)
	data #	data #	data #	data #	data #	data #	data #	data #	data #	data #
3t	1									
4t	1	i2								
5t	1	i3	2							
6t	1	i4	2	i3						
7t	1	i5	2	i4	3					
8t	6	r1	2	i5	3	i4				
9t	6	i7	2	r1	3	i5	4			
10t	6	i8	7	r2	3	r1	4	i5		
11t	6	i9	7	i8	3	r2	4	r1	5	
12t	6	i10	7	i9	8	r3	4	r2	5	r1
13t	11	r6	7	i10	8	i9	4	r3	5	r2
14t	11	i12	7	r6	8	i10	9	r4	5	r3

FIG. 2B

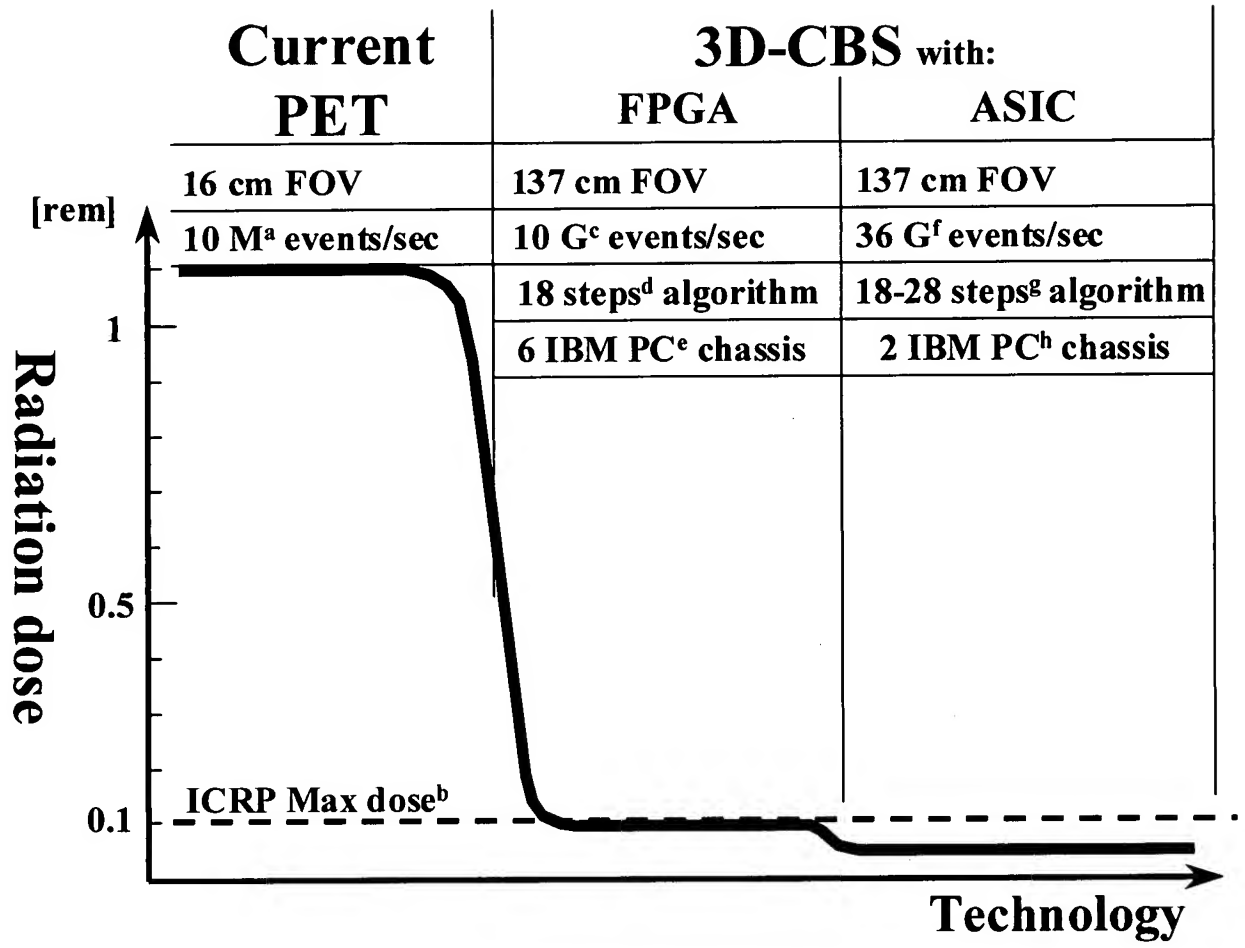
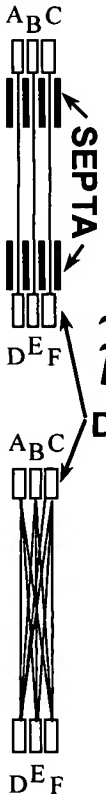

Current PET
3D-CBS with:
FPGA
ASIC
16 cm FOV
137 cm FOV
137 cm FOV
10 M[a] events/sec
10 G[c] events/sec
36 G[f] events/sec
18 steps[d] algorithm
18-28 steps[g] algorithm
6 IBM PC[e] chassis
2 IBM PC[h] chassis
[rem]
1
0.5
0.1
Radiation dose
ICRP Max dose[b]
Technology

FIG. 3

PRIOR ART PET with SHORT FOV



3 possible coincidence detection (LOR) with SEPTA-in:

AD, BE, CF

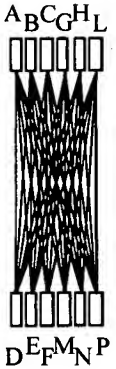
FIG. 4A

9 possible coincidence detection (LOR) with SEPTA-out:

AD, AE, AF,
BD, BE, BF,
CD, CE, CF

FIG. 4B

INCREASING THE FOV



36 possible coincidence detection (LOR) when DOUBLING the FOV:

AD, AE, AF, BD, BE, BF, CD, CE, CF,
GM, GN, GP, HM, HN, HP, LM, LN, LP,
AM, AN, AP, BM, BN, BP, CM, CN, CP,
GD, GE, GF, HD, HE, HF, LD, LE, LF.

FIG. 4C

81 possible coincidence detection (LOR) when the FOV is three times in length.

The 3D-CBS, with over 1 meter FOV, has the capability to capture in 3-D hundreds of times the number of LORs that can capture the current PET when is used in 2-D mode. The limit for each location of the body is about ± 45° the angle with a ring (or $TOF_1 - TOF_2 <$ time window)

FIG. 4D

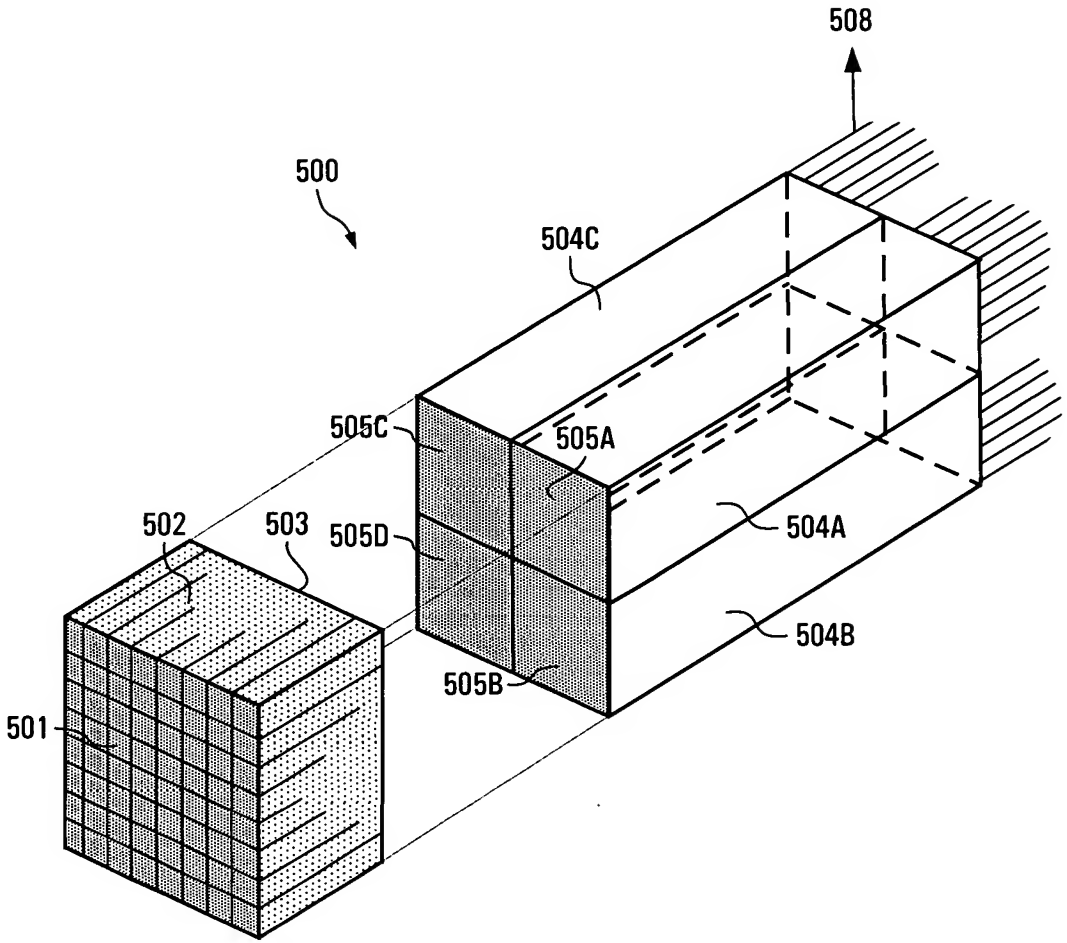


FIG. 5A

Prior Art

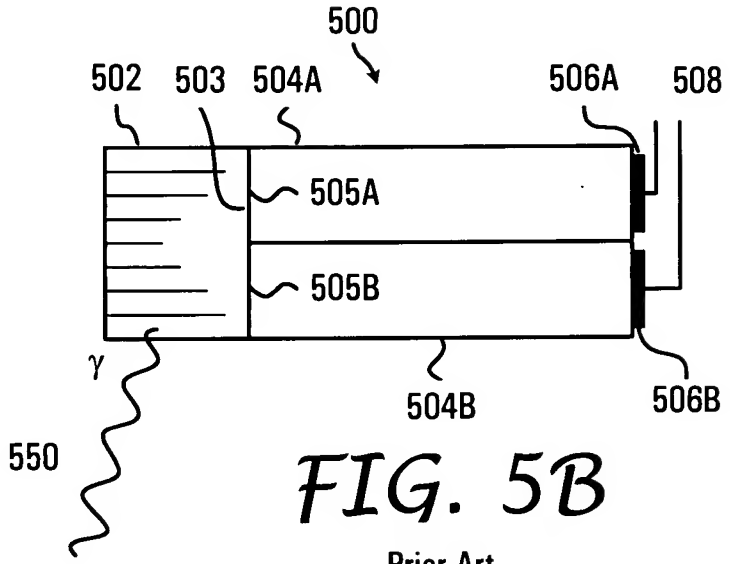


FIG. 5B

Prior Art

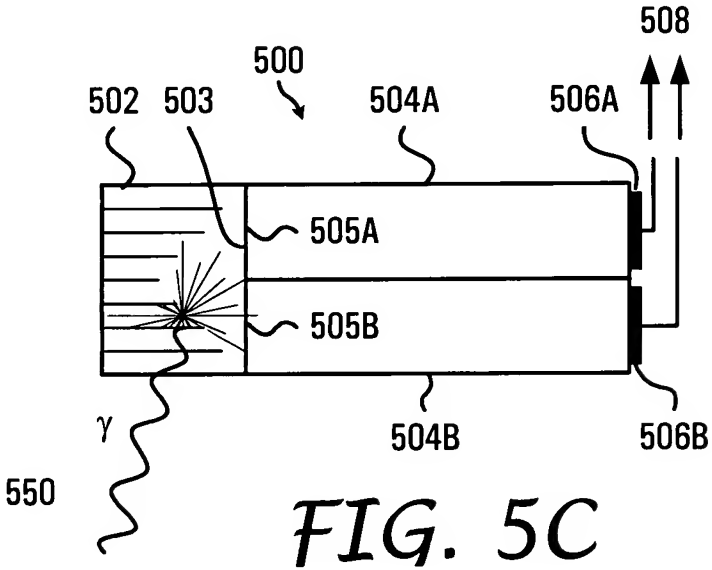


FIG. 5C

Prior Art

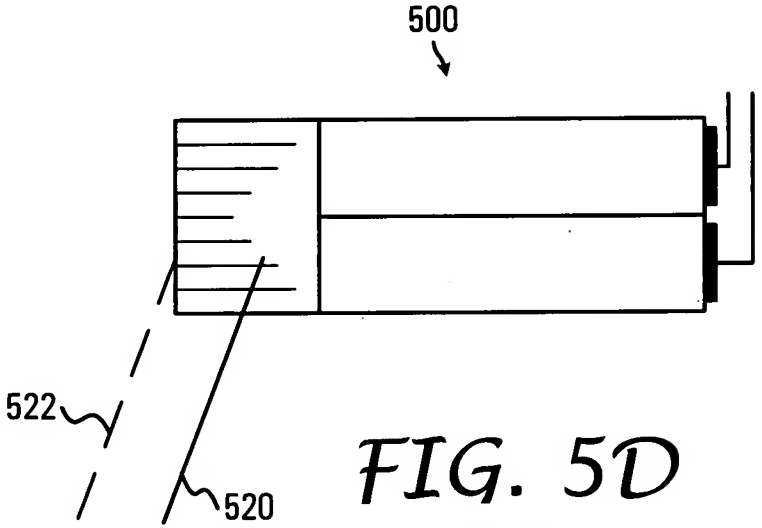


FIG. 5D

Prior Art

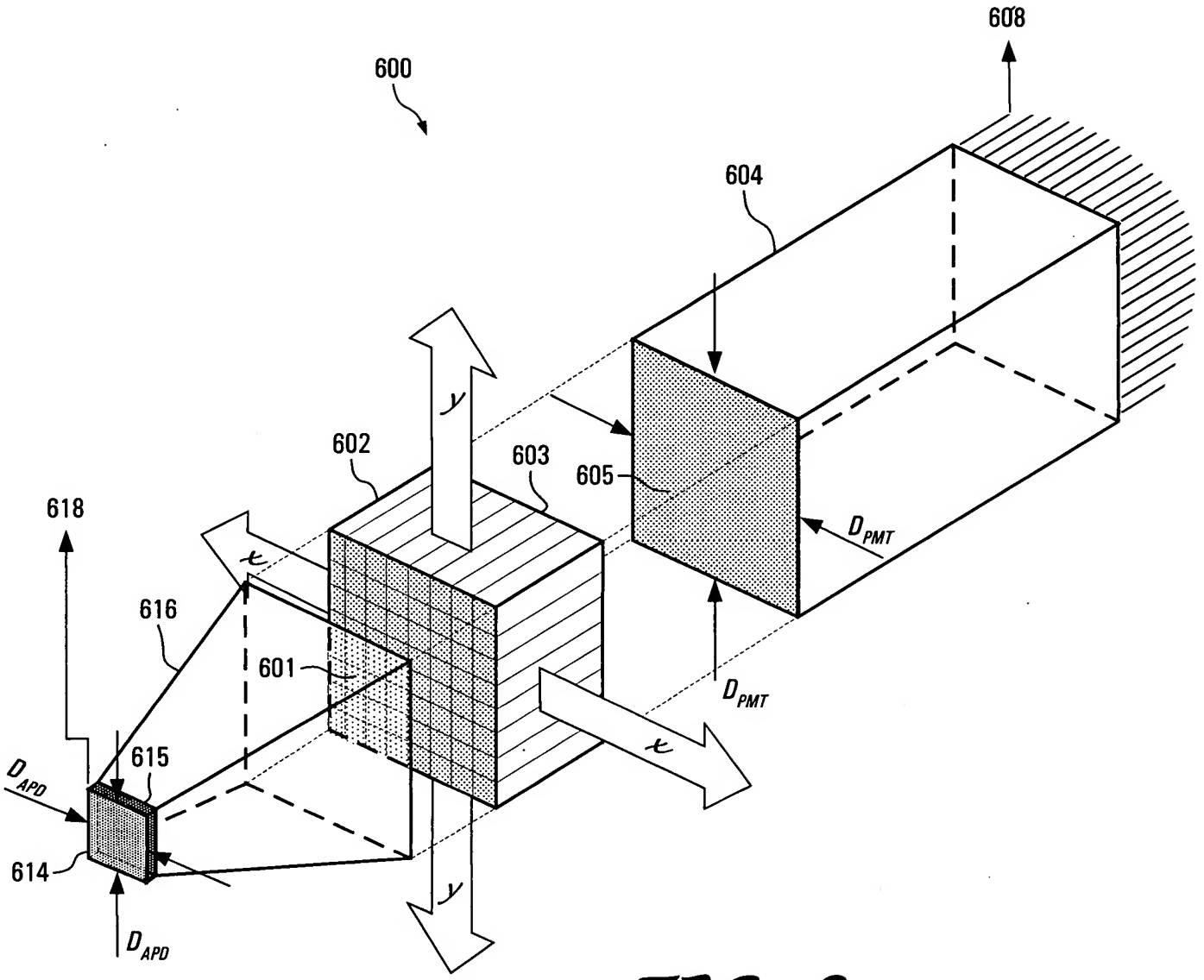

600
608
604
602
603
605
618
616
601
615
614
D_{APD}
D_{PMT}
D_{PMT}
D_{APD}
x
y
x
y

FIG. 6

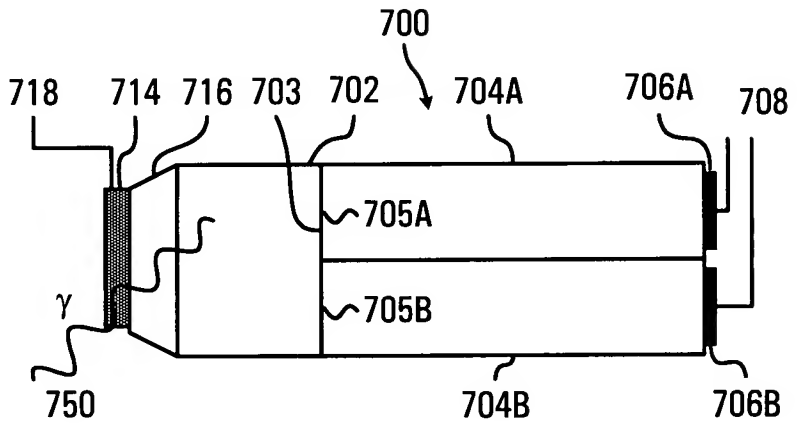


FIG. 7A

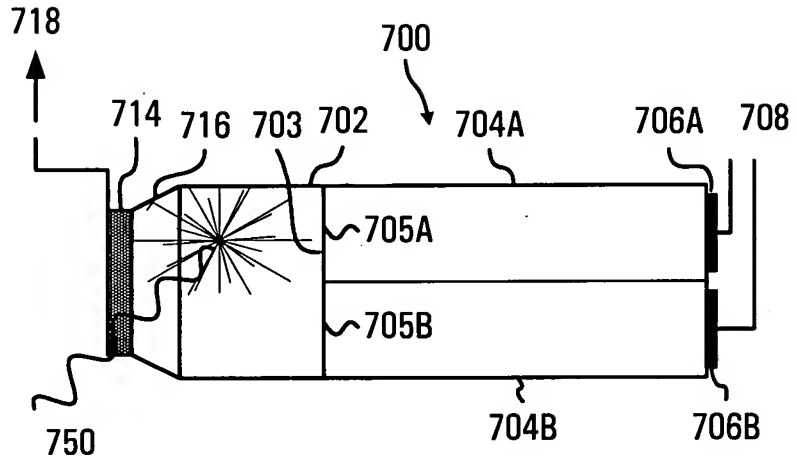


FIG. 7B

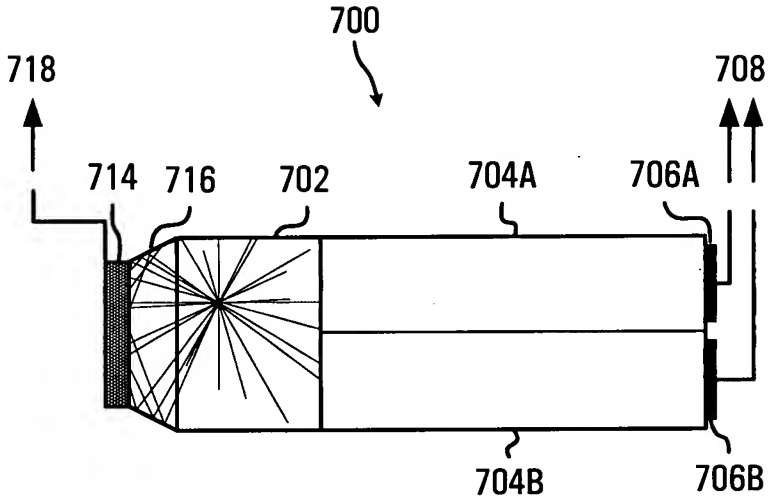


FIG. 7C

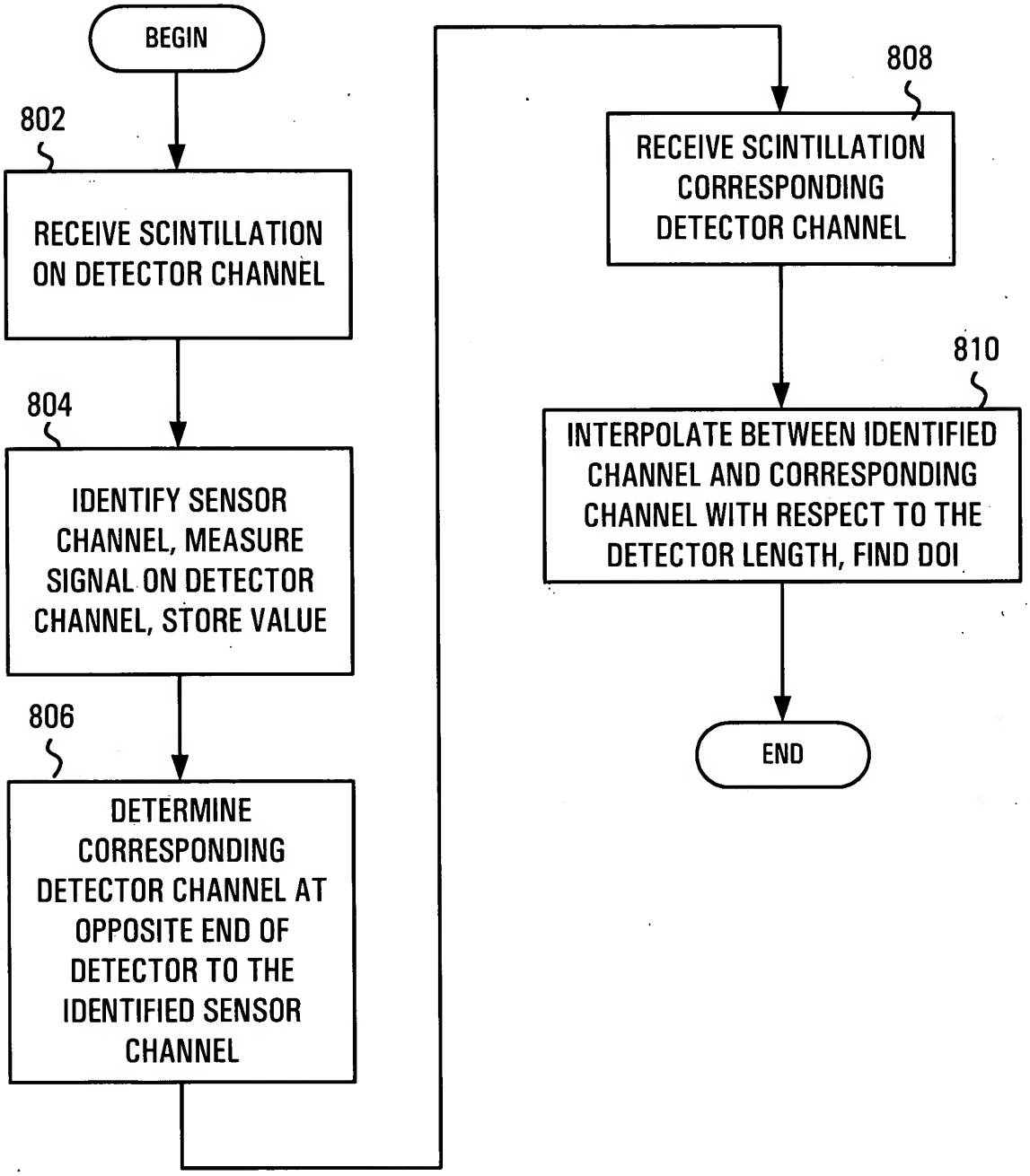

BEGIN
802
RECEIVE SCINTILLATION ON DETECTOR CHANNEL
804
IDENTIFY SENSOR CHANNEL, MEASURE SIGNAL ON DETECTOR CHANNEL, STORE VALUE
806
DETERMINE CORRESPONDING DETECTOR CHANNEL AT OPPOSITE END OF DETECTOR TO THE IDENTIFIED SENSOR CHANNEL
808
RECEIVE SCINTILLATION CORRESPONDING DETECTOR CHANNEL
810
INTERPOLATE BETWEEN IDENTIFIED CHANNEL AND CORRESPONDING CHANNEL WITH RESPECT TO THE DETECTOR LENGTH, FIND DOI
END

FIG. 8